



Exceptional service in the national interest

KOKKOS KERNELS: STATE ON EXASCALE ARCHITECTURES

Carl Pearson

December 12 2023

Kokkos User Group Meeting

KOKKOS KERNELS AND EXASCALE

- Portable math kernels for Kokkos
 - “native” implementations
 - compatibility wrappers for “TPLs”, a.k.a third-party libraries (e.g cuSparse, MAGMA)
- No distributed-memory implementations

Exascale System*	Processor	KOKKOS_ARCH_
Frontier	AMD MI250X GPU	...AMD_GFX90A
El Capitan	AMD MI300A APU	...AMD_GFX942
Aurora	Intel Data Center GPU Max 1550	...INTEL_PVC
Aurora	Intel Sapphire Rapids CPU	...SPR
N/A	Nvidia H100 GPU	...HOPPER90
N/A	Nvidia A100 GPU	...AMPERE80

**current or anticipated*



MI250X (AND MI300A)

- MI300A not available yet
 - AMD contributing early ROCm 6.0 adjustments
- TPLs
 - Broad coverage from rocSPARSE, rocBLAS,
 - Support from rocSOLVER in progress
- Known Issues
 - None (ROCm 5.6.0)
- PR tests on MI210



INTEL PONTE VECCHIO

- Recent access to Aurora: Intel Data Center Max GPU 1550
- TPLs
 - spotty oneMKL coverage, more in progress
- Known Issues
 - native SpGEMM
 - native COO -> CRS matrix conversion
 - oneMKL gemv NaN handling (reported to Intel, may already be fixed on Aurora)
 - investigating potential SpMV performance regression / misuse in oneMKL 2024 vs 2023
- Nightly SYCL tests in place on Data Center GPU Max 1100
 - working on promoting to PR tests
 - Much smaller: 1/2 cores, 1/3 HBM



INTEL SAPPHIRE RAPIDS

- TPLs
 - Broad coverage of BLAS and sparse from oneMKL
- Known Issues
 - Mishandling of integer size types on some oneMKL configurations
- Nightly tests with KOKKOS_ARCH_SPR

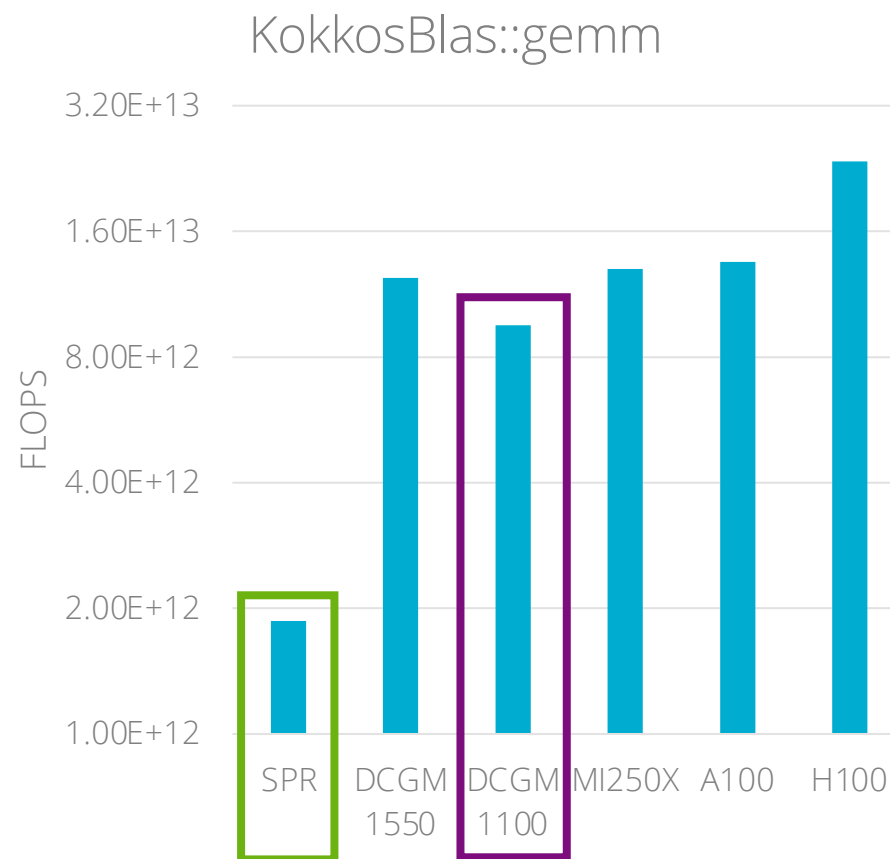
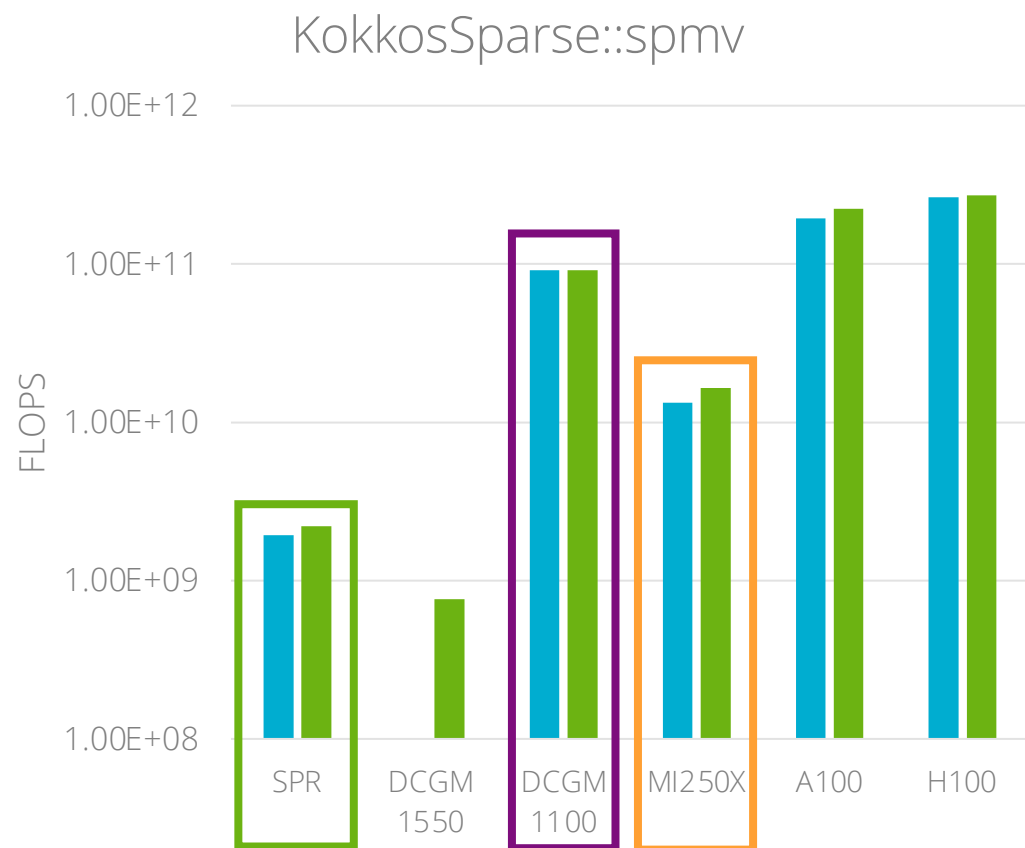


NVIDIA H100, A100

- TPLs
 - Broad coverage from cuBLAS, cuSPARSE, and cuSOLVER
- Known Issues
 - None (CUDA 11.8)
 - Batched dense (H100, CUDA 12)
- Nightly tests on H100
 - Working on transitioning V100 PR tests to A100 or H100



SPMV AND GEMM PERFORMANCE RESULTS



no stacked HBM

smaller GPU than Aurora

AMD is working on this

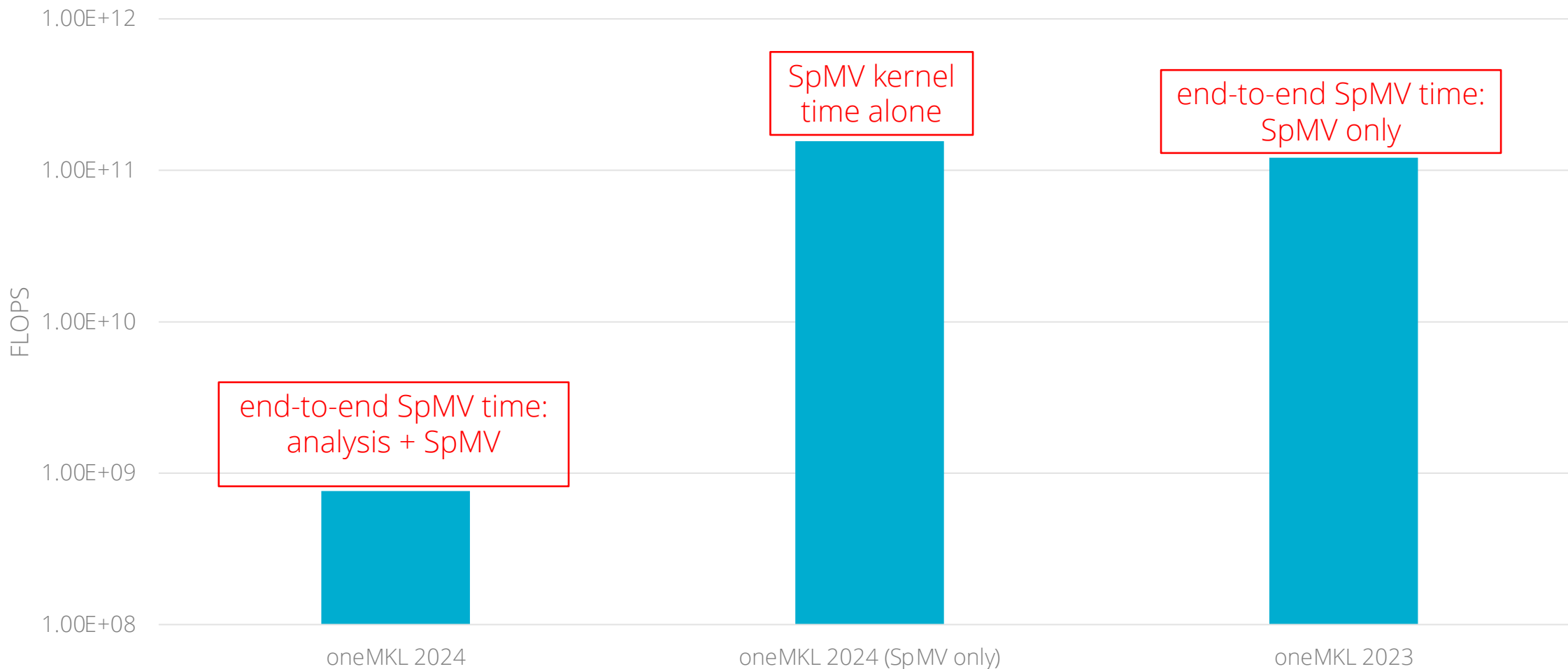
next slide

- fp64, N=1.8M, nnz=88M
- fp64, N=1.1M, nnz=89M

fp64, m=n=k=1000



POSSIBLE SPMV REGRESSION IN MKL2024



previous slide



NOTES ON THE PREVIOUS RESULTS

- SPR: Sandia: oneAPI 2023.1.0
- MI250X: Frontier @ OLCF, ROCm 5.3.0
- DCM 1100: Sandia, oneAPI 2023.1.0
- DCM 1550: Aurora @ ALCF, oneAPI 2024
 - preliminary investigation suggests optimize_gemv SpMV analysis pass was a no-op prior to oneMKL 2024, now causing a performance regression
- A100: Perlmutter @ NERSC: CUDA 11.7
- H100: Sandia: CUDA 11.8

ACKS

This research used resources of the **Argonne Leadership Computing Facility**, a U.S. Department of Energy (DOE) Office of Science user facility at Argonne National Laboratory and is based on research supported by the U.S. DOE Office of Science-Advanced Scientific Computing Research Program, under Contract No. DE-AC02-06CH11357.

This research used resources of the **Oak Ridge Leadership Computing Facility** at the Oak Ridge National Laboratory, which is supported by the Office of Science of the U.S. Department of Energy under Contract No. DE-AC05-00OR22725.

This research used resources of the **National Energy Research Scientific Computing Center**, which is supported by the Office of Science of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.